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ABSTRACT

The purposes of this study were to assess the development of hemispheric dominance for language function among children of 4, 7, and 10 years of age and to determine whether age predicts hemispheric dominance. Within 2 weeks of the beginning of data collection, middle-class subjects selected from private nursery schools and elementary schools passed a hearing screening administered by an audiologist. Experimental testing then consisted of an individually administered dichotic listening examination in which each subject heard two different words simultaneously through stereo headphones. Twenty-four groups of two pairs of dichotically presented words were heard by each subject. After hearing each group of words, the subject was asked to report, in any order, all of the words he or she remembered. Scores were calculated by subtracting the right-ear score from the left-ear score and then dividing by the total number of correct responses for both ears. The dichotic listening task included four identical trials in order to assess the reliability of the instrument. Higher right-ear (left hemisphere) scores were found across all groups. The number of subjects with little difference between right and left hemisphere scores increased with age. In view of the traditional emphasis on left hemisphere learning in schools it is concluded that hands-on curriculum experiences providing young children with the opportunity to learn more right brain strategies would be beneficial. (RH)

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Assessment of Hemispheric Dominance for Language at Three Ages

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Paper presented at the annual conference of the

Southern Association for Children Under Six

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Introduction

The purpose of this study was to assess the development of hemispheric dominance in childhood. Hemispheric dominance (sometimes called hemisphericity) is the tendency for a person to rely more on one than the other cerebral hemisphere in processing information (Torrance & Mourad, 1979, p. 44). Research in this area is involved with the "study of the functional organization of the brain according to left or right hemisphere" (Rubenzer, 1979, p. 79). As far back as the 19th century scientist documented the dichotomy of the brain. Many of these ideas about the functional uniqueness of the two sides of the brain were confirmed by the research of Roger Sperry and others. Sperry (1964) experimentally severed the corpus callosum in laboratory animals. The corpus callosum is the structure connecting the two cerebral hemispheres and through which the two sides of the brain communicate. Sperry's experimental procedures were later adapted for human epilepsy patients in an attempt to control eplipetic seizures from spreading across the brain.

At any rate, the subsequent research in the area of hemispheric dominance has shown that each hemisphere of the brain may be specialized for certain abilities. Researchers such as Galin (1976), Gazzaniga (1967), Kimura (1973), Languis (1977), and Sperry (1975) should be noted here. This specialization does not exclude the notion of interhemispheric communication, i.e., although one side of the brain may be better suited for a specific type of thought, communication between the two hemispheres may facilitate the total thought process.

There has been speculation by Gazzaniga and LeDoux (1978) about the development of interhemispheric communication in young children, i.e., the ability to integrate right and left hemisphere operations. For example, the left hemisphere is traditionally thought to be verbal, while the right hemisphere is associated with spatial ability. Therefore, when a person describes verbally how to complete a maze, he is integrating the verbal and spatial, left and right hemispheres. It seems appropriate to note that this task is difficult for a preschool age child. (The author does not mean to disregard the many other operations which are associated with one or both hemispheres of the brain, but only to use the traditional dichotomy, verbal/spatial as an example).

There are several theories about the development of hemispheric dominance in children. Gazzaniga and LeDoux (1978) discussed a model of development based on competition for synaptic space. Also, considered were developmental trends, as they are seen in specific processing channels. A physiologically based theory emphasized the growth of the corpus callosum as a key factor in the development of hemispheric dominance of function and interhemispheric communication, i.e. the corpus callosum may not be completely developed until as late as age ten. Therefore, communication between the two hemispheres may be developing throughout childhood. Witelson (1977) reviewed a wealth of research on this topic. Among her conclusions were: a) the age of five may be associated with a change in plasticity of hemispheric functions, i.e. it is a critical age in the development of some cognitive skills; and b) in early development, the right hemisphere may play a role for language development, analogous to the traditional verbal left

hemisphere. The purpose of this study was to assess hemispheric dominance for language function at three age levels (four, seven and ten) and to determine if age predicts hemispheric dominance.

Subjects

The middle class subjects were selected from private nursery schools and elementary schools. The subjects were assigned to three groups according to age: group I, 27 subjects (11 males, 16 females), mean age of 4 years, 8 months; group II, 30 subjects (11 males, 19 females), mean age of 7 years, 6 months; group III, 35 subjects (17 males, 18 females), mean age of 10 years, 6 months. All subjects passed a hearing screening, administered by an audiologist, within two weeks of data collection.

Dichotic Listening

A dichotic listening test, based on contralateral cerebral pathways was administered to each subject individually. Each subject heard two different words simulataneously through stereo headphones. A Wollensak portable stereo cassette tape recorder was used. Volume imbalance was controlled by counterbalancing the headphones. Because a shift in synaptic processing seems to occur in the early years and because of the developmental nature of this study, the use of single word material was used for the dichotic listening phase of this investigation to insure that the processing mechanism for all aged subjects would be similar. A controlled order of report was utilized to add a further control to the techniques. The audio tapes used were constructed by Sawyers (1979). She reported the established word association

norms as matched for number of syllables and letters and as having the "same primary association for both sexes and ....no associative connection to any other word in the same four-pair group" (p. 47). Twenty four groups of two pairs of dichotically presented words were heard by each subject. After each group of words the subject was asked to report, in any order, all of the words remembered. Two initial practice trials (trials one and two) were done to insure that the subject understood the instructions. Trials 23 and 24 were a reiteration of trials 11 and 12 (designed to check reliability). Twenty trials were scored.

Scores were calculated by subtracting the right ear score from the left ear score and then dividing by the total number of correct responses for both ears. The scores ranged from -1.0 to +1.0 (-1.0 = right dominance and +1.0 = left dominance), with 0.0 representing a subject with an equal number of right and left hemisphere responses. The means and standard deviations of these scores are presented in Table 1.

Results and Discussion

The dichotic listening task was designed with four identical trials (trial 11, 12 and trial 23, 24) in order to assess the reliability of the instrument. Each subject was scored for the number of identical responses given on these four trials, regardless of whether the responses was correct. A consistency score was computed by dividing the number of identical responses by the total number of responses. These results are presented in Table 2. For the total group, the consistency score was 68%. Consistency scores of 70.7%, 60.2%, and 73.1% were reported for groups I, II, and III, respectively.

Figures 1 and 2 show the frequency of scores of the dichotic listening task. These scores fall between -1.0 and +1.0. Higher right ear (left hemisphere) scores were found across all groups. This right ear superiority was consistent with findings reported by Witelson (1977). Right ear superiority for processing language was found as early as three years of age and possibly in infancy (Witelson, 1977).

The next step in the analysis was to assign an absolute value to the dichotic listening task scores. A low absolute value represented a subject with an undifferentiated score, i.e., a subject who had little difference between his right and left hemisphere scores. A high absolute value represented a subject with more highly differentiated scores, i.e., a subject whose responses were either predominantly right or left hemisphere. The results indicated that the number of subjects with low scores increased with age (Figure 3). The correlation coefficient between age and the absolute value of the dichotic listening task scores was ($r = -.19$, $p < .03$. The frequencies in Figure 3 indicated that the patterns for groups II and III are similar while for group I the pattern deviates. Ignoring the last datum point on Figure 3 (.76 to 1.0 had very low frequencies for all groups), the differences between group I and groups II and III were more obvious.

Is this pattern of increased undifferentiated dichotic listening task scores with age the result of physical neurological maturation, as suggested by some theorists? Galin and others (1979) suggested that the increase in interhemispheric communication may be a possible explanation for the acquisition of Piagetian conservation and reversibility. In 1976, Kraft assessed the hemispheric functioning of six to eight year old children using and EEG and found that children who conserved had more balanced brain wave activity

between hemispheres on both manipulospatial and verbal tasks. Regarding the results of Kraft's research and of the present study, preschool educators may be reminded of the futility of teaching Piagetian tasks, per se.

Based on the results of this research, any discussion of learning style must be viewed from a developmental persepctive. Preschool and elementary teachers must recognize that a child's learning style may change as inter-hemispheric communication improves. With an increase in age, and in cognitive growth comes the ability to better use both hemispheres.

Our schools have been traditionally skewed toward left hemisphere learning, evidenced by the emphasis on verbal skills, reading, and writing. Languis and others (1980) suggested that schools restructure and develop "more adequate models of learning styles to better explain individual differences" (p. 50). This attitude will give the non-verbal little boy who may be proficient at using right brain strategies a better chance at success. Similarly, the verbal little girl will benefit from the opportunity to learn right brain strategies. To reiterate, one way to achieve a more balanced school program is to provide children with the opportunity to learn more right brain strategies, such as hands-on curriculum experiences. Huff and Languis (1973) showed that language skills increased in curriculum which emphasized right brain strategies.

If interhemispheric communication does indeed increase with age, as the results of this research have indicated, then a young child who has developed both right and left brain strategies may be an advantage as neurological maturation occurs. When presented with a task, he may be able to integrate a greater warehouse of strategies or he may be able to choose, in degrees, the more efficient hemisphere.

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Table 1

Means, Standard Deviations, and Range

of Hemispheric Dominance Scores

Group	n	Means	SD	Range
I	27	.18	.54	-.19 to +.93
II	30	.23	.36	-.47 to +.83
III	35	.09	.44	-.85 to +.93

Table 2

Consistency Score for Dichotic Listening Task

Group	$\bar{X}$ Consistency Score	n	Missing Data
I	70.70	23	4
II	60.21	24	6
III	73.09	34	1
Total	68.00	81	11

Figure 1

Frequency of Hemispheric Dominance Scores by Group

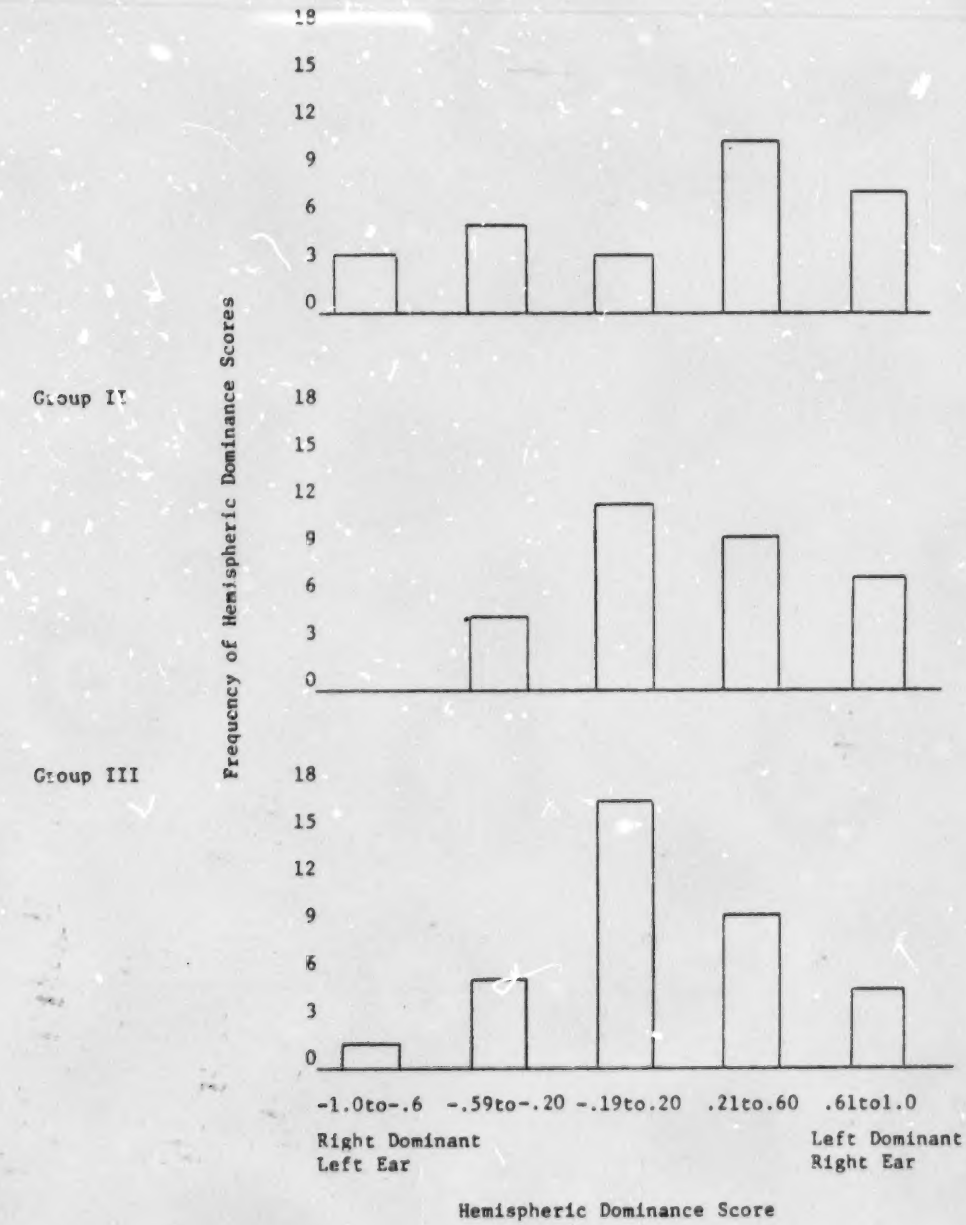

Figure 2

Frequency of Hemispheric Dominance Scores

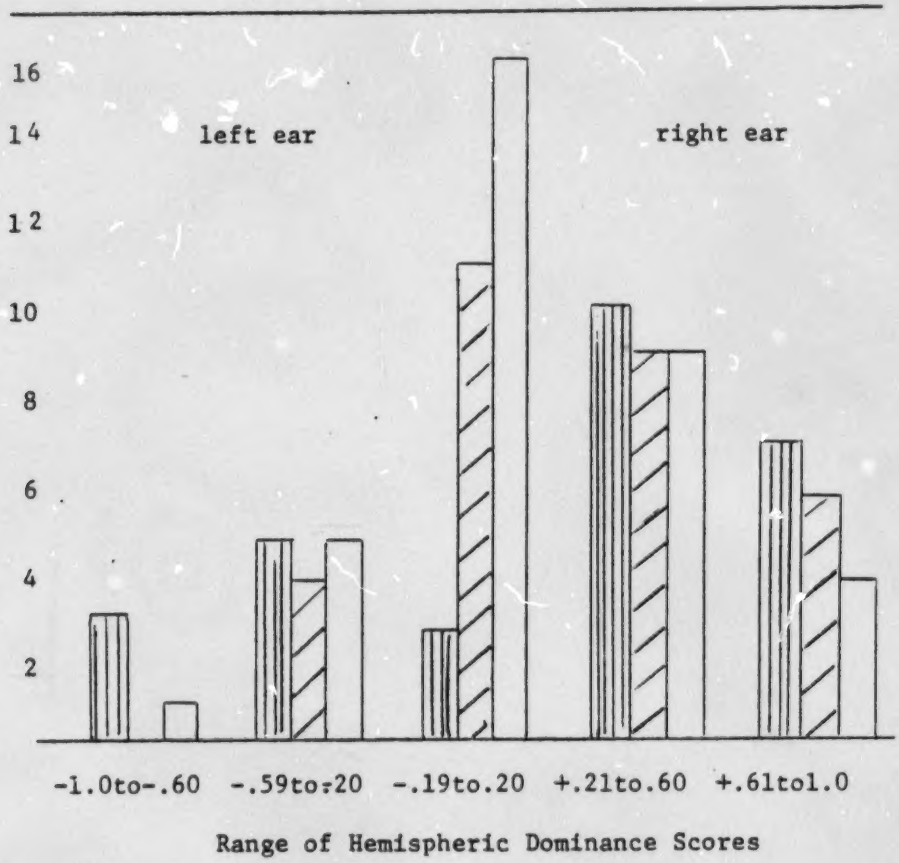

Figure 3

Frequency of Absolute Value of Hemispheric Dominance Scores by Group